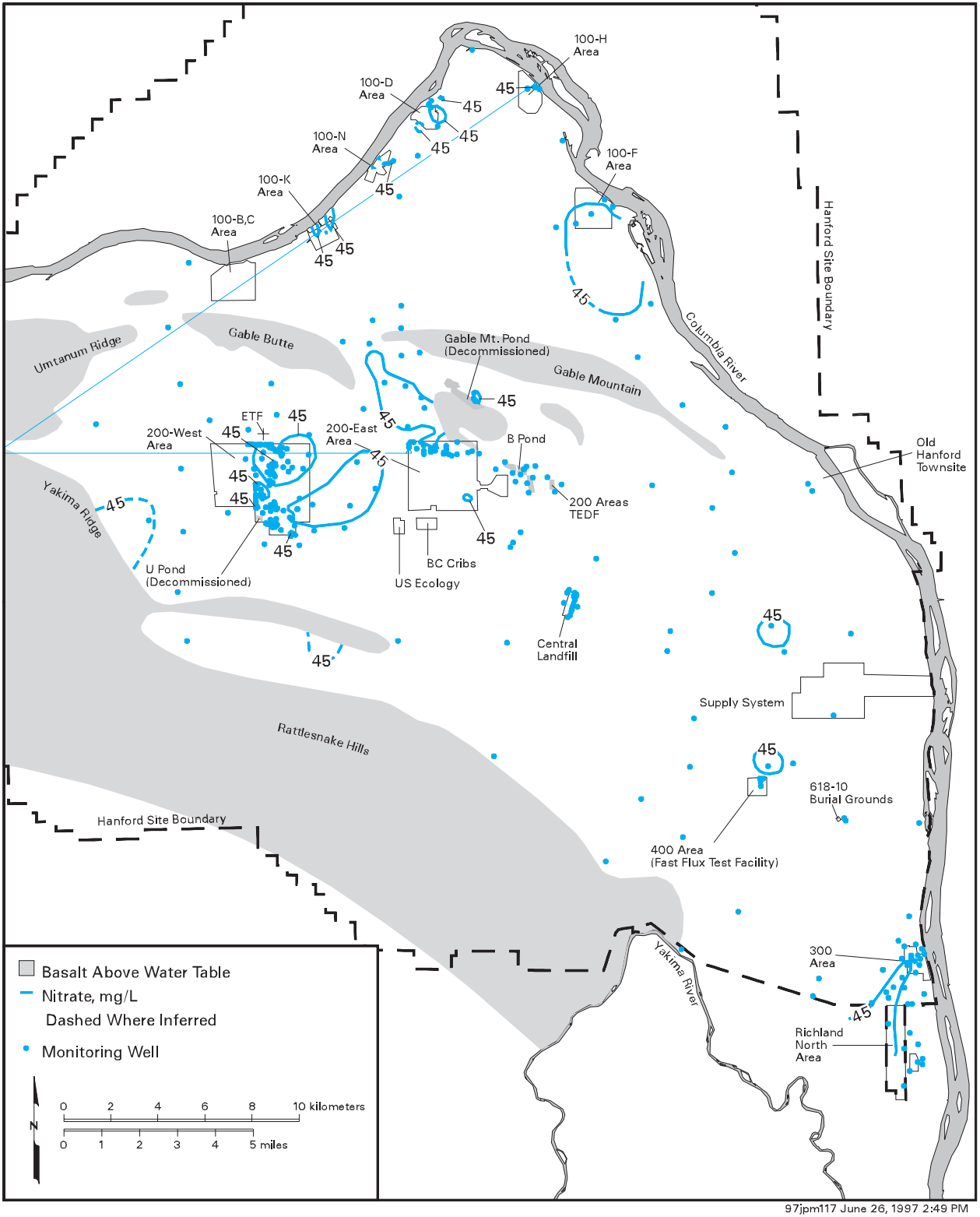
Figure 4.8.35. Distribution of Nitrate in the Unconfined Aquifer, 1996



97jpm117 June 26, 1997 2:49 PM

Most nitrate analyses performed onsite in recent years have been performed using the ion chromatography method. However, a colorometric method also has been used. The colorometric results appear prone to erratic errors, and these results are being investigated. Several results for colorometric nitrate analyses have been excluded from the discussion below because they are off trend from other analyses and are considered suspect.

Nitrate in the 100 Areas. Nitrate is found at levels greater than the 45-mg/L drinking water standard in parts of the 100-D Area. The highest nitrate value found in the 100-D Area in 1996 was 119 mg/L in well 199-D8-3, located in the northern part of the area near the Columbia River.

The 100-F Area contains nitrate in groundwater at levels greater than the drinking water standard. This plume appears to extend to the south into the 600 Area but the extent of nitrate at low levels in the 600 Area west and south of the 100-F Area suggests there is an unknown source upgradient. The maximum nitrate detected in the 100-F Area in 1996 was 100 mg/L in well 199-F5-47, located in the central part of the 100-F Area.

Nitrate in the 100-H Area is restricted to a small area downgradient of the former 183-H Solar Evaporation Basins. The maximum concentration of nitrate detected in this area in 1996 was 1,300 mg/L in well 199-H4-3.

Nitrate at levels greater than the drinking water standard in the 100-K Area is found downgradient of both the K-East and K-West Reactors. The maximum concentration detected in 1996 was 98 mg/L in a sample from well 199-K-18.

Minor nitrate contamination is found in parts of the 100-N Area. The maximum detected in a 1996 sample was 220 mg/L in well 199-N-19, located between the 1301-N Liquid Waste Disposal Facility and the Columbia River.

Nitrate in the 200-East Area. The highest nitrate concentrations in the 200-East Area continued to be found near liquid waste disposal facilities that received effluent from Plutonium-Uranium Extraction Plant operations. Nitrate concentrations in wells near the 216-A-10 and 216-A-36B Cribs generally have tended to decrease in the past few years but remained greater than the drinking water standard even though these facilities were removed from service in 1987. The maximum nitrate concentration detected in this vicinity was 137 mg/L in well 299-E17-9 adjacent to the 216-A-10 Crib. The nitrate plume related to Plutonium-Uranium Extraction Plant operations is coincident with the tritium plume shown in Figure 4.8.12. However, as shown in Figure 4.8.35, nitrate is only found at levels above the drinking water standard in a few restricted places in the 200-East Area. High nitrate concentrations in the 600 Area north of the 200-East Area are apparently related to past disposal practices at the BY Cribs. Nitrate was detected in well 699-49-57A at 95 mg/L in 1996. Nitrate is also found in a few wells near the former Gable Mountain Pond, north of the 200-East Area. The highest measured concentration in this area was 320 mg/L at well 699-53-48A.

Nitrate in the 200-West Area. Nitrate concentrations greater than the drinking water standard were widespread in groundwater beneath the 200-West Area and adjacent parts of the 600 Area. The major nitrate plumes were found in wells east of U Plant and wells in the north-central part of the 200-West Area. The highest nitrate concentrations across the site continued to be found in wells east of U Plant near the 216-U-17 Crib, where the maximum concentration detected in 1996 was 1,100 mg/L (well 299-W19-26). Well 299-W19-30, which showed a concentration of 1,400 mg/L in 1995, was not sampled during 1996. The presence of nitrate in wells near this crib was observed before February 1988, when the crib went into operation. The source of nitrate is believed to be wastes disposed of in the 216-U-1 and 216-U-2 Cribs, west of U Plant. These cribs received over 1,000,000 kg (2,200,000 lb) of nitrate during their operation from 1951 to 1967 (Stenner et al. 1988). Nitrate concentrations in wells located near the 216-U-1 and 216-U-2 Cribs continued to decrease, with concentrations in several of the wells dropping to less than the drinking water standard.

Several wells in the northern part of the 200-West Area continued to contain nitrate at concentrations greater than the drinking water standard. These wells are located near several inactive liquid waste disposal facilities that received waste from early T Plant operations. Maximum concentrations in these wells in 1996 ranged up to 1,100 mg/L in well 299-W10-1. The area with groundwater nitrate at levels greater than the drinking water standard extends from the vicinity of the Plutonium Finishing Plant to approximately the northeast corner of the 200-West Area.

Nitrate in Other Areas. Although most nitrate observed onsite is the result of Hanford operations, elevated nitrate concentrations in wells in the western part of the site appear to be the result of increasing agricultural activity

in Cold Creek Valley. There is no known source of nitrate in that area associated with site operations, and the groundwater flow is from the west toward the Hanford facilities to the east. Nitrate levels have fluctuated considerably in wells upgradient of the 200 Areas over the past 30 years. Nitrate levels have been near or greater than the drinking water standard in well 699-36-93 since 1985. The concentration at this well in 1996 was 48 mg/L.

Nitrate concentrations near the city of Richland and in the 1100 Area, 3000 Area, and adjacent parts of the 600 Area are also apparently affected by offsite nitrate sources. These sources may include agriculture, food processing, urban horticulture, and nuclear fuel manufacturing at offsite commercial facilities. The part of this plume with nitrate concentrations greater than the drinking water standard extends from offsite to the 300 Area.

High nitrate concentrations have been reported offsite in parts of Grant, Adams, and Franklin Counties to the east and north of Hanford. Ryker and Jones (1995) report that 28% of the wells sampled in this area had nitrate concentrations above the drinking water standard. The nitrate is related, in general, to fertilizer and water usage and has been increasing since the 1950s. This nitrate may impact surface-water quality (see Section 4.2, "Surface Water and Sediment Surveillance") and groundwater in the area north of the Columbia River.

Cyanide

Waste fractionation activities performed in the late 1950s used large quantities of sodium and nickel ferrocyanide to recover cesium-137. Large volumes of aqueous supernatant waste containing excess ferrocyanide were disposed to the ground in both the north and south portions of the 200-East Area. Smaller quantities were also disposed to cribs in the 200-West Area. Procedures used to analyze for cyanide do not distinguish between ferrocyanide and free cyanide. Cyanide results reported here are, thus, normally assumed to be residual ferrocyanide associated with the discharges from the waste fractionation activities performed more than 30 years ago. A chemical speciation study performed in 1988 indicated that approximately one-third of the cyanide in groundwater is present as free cyanide and the rest may be present as ferrocyanide (Evans et al. 1989a, 1989b). The drinking water standard for cyanide is 200 µg/L.

Cyanide was detected in samples collected from wells in the northwestern part of the 200-East Area and in the 600 Area north of the 200-East Area. No samples collected in 1996 contained cyanide at levels above the drinking water standard. Well 699-52-54 had the highest concentration, with 140 µg/L of cyanide. Wells containing cyanide often contain concentrations of several radionuclides, including cobalt-60. Although cobalt-60 is normally immobile in the subsurface, it appears to be chemically complexed by cyanide or ferrocyanide. The complexed chemical species is more soluble and more mobile in groundwater.

Low-level cyanide contamination is often found in limited locations in the 200-West Area. Cyanide has been detected in past years near the 216-T-26 Crib, which received a total estimated inventory of 6,000 kg (13,000 lb) of ferrocyanide from 1955 to 1956 (Stenner et al. 1988). Low levels of cyanide are also occasionally detected near U Plant and into the 600 Area between the 200-West and 200-East Areas. In particular, well 699-44-64, which is relatively distant from potential source areas, consistently contains detectable cyanide (24 µg/L in 1996).

Fluoride

Fluoride currently has a primary drinking water standard of 4.0 mg/L and a secondary standard of 2.0 mg/L. Secondary standards are based primarily on aesthetic rather than health considerations. Fluoride was detected at levels greater than the primary drinking water standard at a few wells near T Plant in the 200-West Area in 1996. Well 299-W10-15 showed a maximum fluoride concentration of 7.8 mg/L, and well 299-W15-4 had a maximum concentration of 4.8 mg/L. Aluminum fluoride nitrate used in the 200-West Area processes is the probable source of the fluoride contamination.

Chromium

Chromium use on the Hanford Site has been extensive. In the 100 Areas, sodium dichromate was added to cooling water as a corrosion inhibitor, and some residual chromium remains from that use. Hexavalent chromium was used for decontamination in the 100, 200, and 300 Areas, and also was used for oxidation state control in the Reduction-Oxidation Plant process. In the hexavalent form, chromium is present in an anionic state. Thus, hexavalent chromium is freely mobile in the groundwater. The federal drinking water standard for chromium is 100 µg/L, and the state standard is 50 µg/L.

Both filtered and unfiltered samples were collected for analyses of chromium and other metals from several of the wells onsite. Unfiltered samples may contain metals

present as particulate matter, while filtered samples are representative of the more-mobile dissolved metals. Filtered samples may also contain some colloidal particles that are fine enough to pass through the filter. Drinking water standards are based on unfiltered concentrations; however, differences in well construction and pumping practices between monitoring wells and water-supply wells make it difficult to predict potential drinking water concentrations from monitoring well data when the metals are present as particulate matter. In general, filtered samples provide the best indication of groundwater contamination levels for chromium because unfiltered samples are subject to greater variability introduced by the sampling process. Chromium concentrations in filtered samples will be used to describe the level of contamination in the discussion below.

Chromium in the 100 Areas. Chromium has been detected in groundwater from wells in each of the 100 Areas. Chromium concentrations in filtered samples collected from the 100-B,C Area in October 1995 were above the state drinking water standard in well 199-B5-1, which showed a maximum concentration of 88.6 µg/L. No wells in this area were analyzed for chromium during 1996.

High chromium concentrations were detected at similar levels in both filtered and unfiltered samples from the 100-D Area. This indicates that the chromium concentrations are representative of the mobile concentrations in groundwater. The maximum chromium concentration from filtered samples in the 100-D Area in 1996 was 727 µg/L in well 199-D5-14. The chromium distribution in the 100-D Area is shown in Figure 4.8.36.

Relatively few chromium analyses are available from the 100-F Area for 1996. However, several wells were sampled during the last few months of 1995. The highest concentration was 153 µg/L detected at well 199-F5-46 in November 1995. This was the only well that was above the drinking water standards.

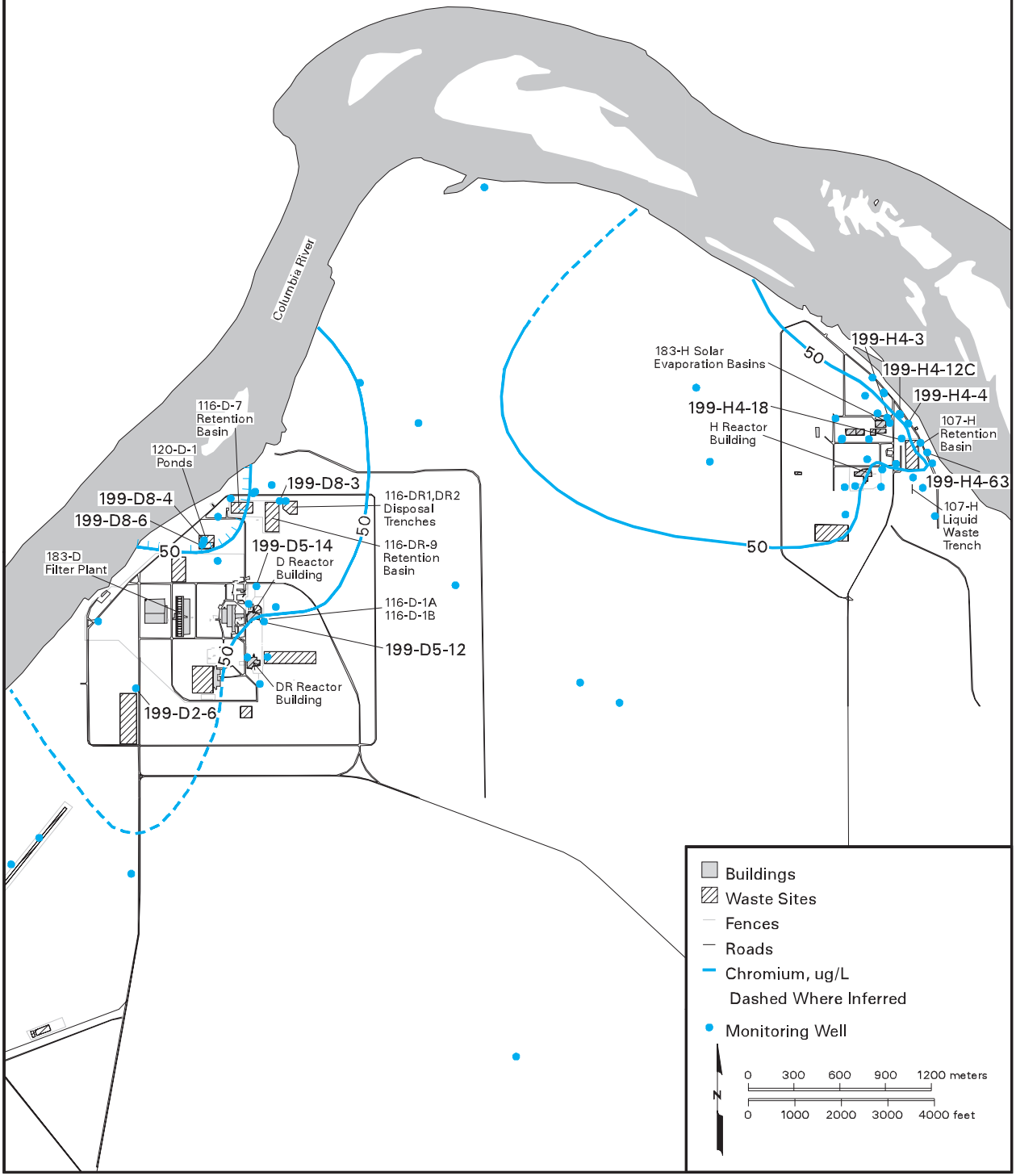
Many samples from the 100-H Area contained chromium at levels greater than the drinking water standard (see Figure 4.8.36). Chromium was often present at similar levels in both filtered and unfiltered samples. The maximum chromium concentration from 100-H Area filtered samples collected from the shallow parts of the unconfined aquifer in 1996 was 240 µg/L in well 199-H4-3. Chromium is also found at levels above the drinking water standard in deeper parts of the unconfined aquifer in the 100-H Area. For example, samples from well 199-H4-12C contained up to 277 µg/L chromium in filtered samples in 1996. Potential chromium sources in the 100-H Area include disposal of sodium dichromate near the H Reactor building, disposal to the 107-H Liquid Waste Disposal Trench, and chromium in acid wastes stored in the 183-H Solar Evaporation Basins (Peterson and Connelly 1992). Chromium was also detected in parts of the 600 Area upgradient from the 100-H Area, indicating an upgradient source, which is probably the 100-D Area. Effluent releases at the 100-D Area during operations produced groundwater mounding, which altered flow conditions. This caused the spreading of chromium contamination into the 600 Area.

Chromium is found in both filtered and unfiltered samples from the 100-K Area at levels greater than the drinking water standards (Figure 4.8.37). The maximum concentration in 1996 was 2,710 µg/L in well 199-K-36, near the K-East Reactor filter plant. Chromium is also found at levels above the drinking water standard near the 116-K-2 Liquid Waste Disposal Trench and the K-West Reactor.

At the 100-N Area, only two wells sampled in 1996 contained filtered chromium at concentrations greater than the drinking water standards. Well 199-N-33 had a maximum concentration in filtered samples of 430 µg/L. Well 199-N-80 had a maximum concentration of 178 µg/L. Well 199-N-80 is completed in the deeper part of the unconfined aquifer and suggests that the chromium distribution at depth is different from that near the water table.

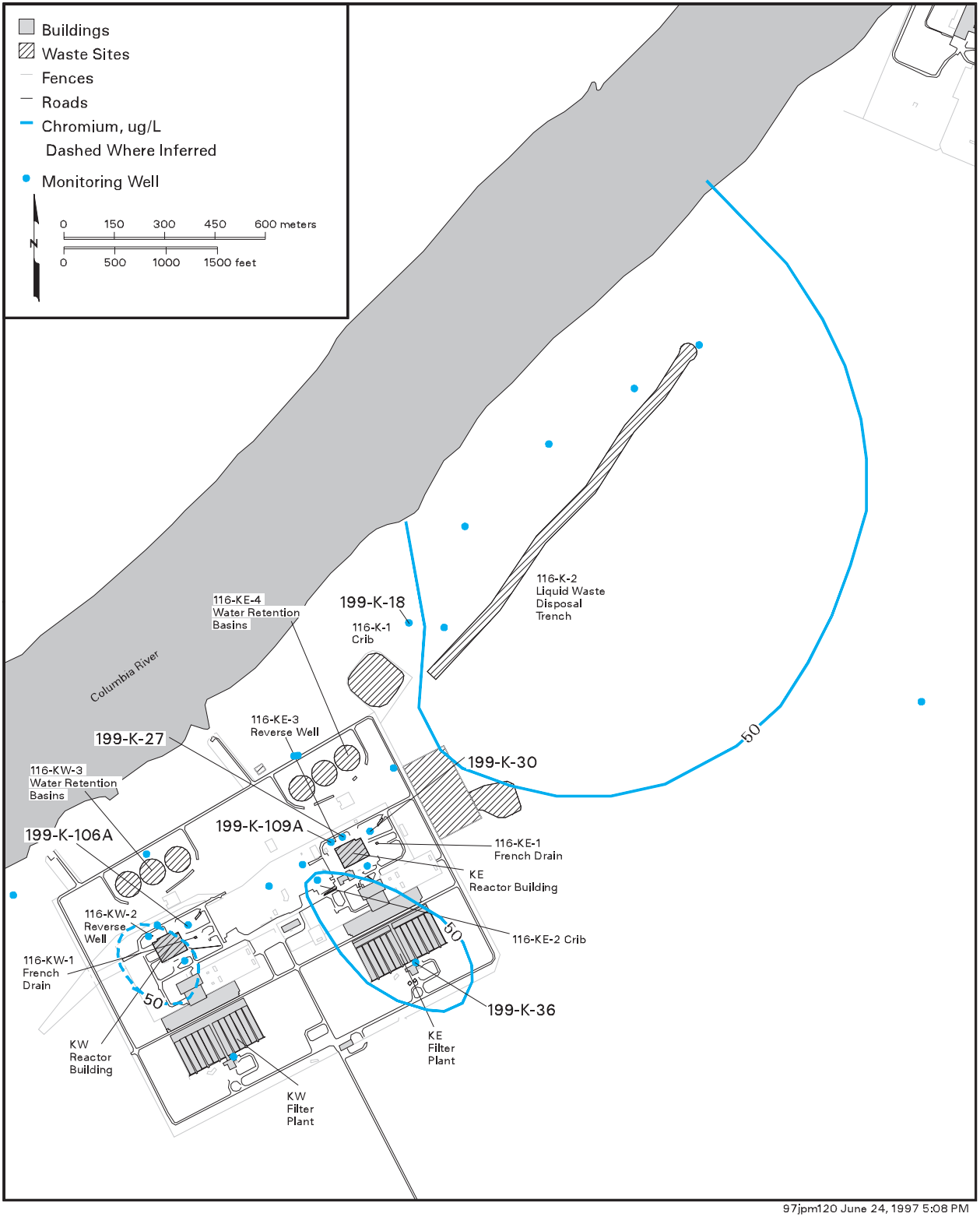
Chromium in the 200 Areas. Chromium at concentrations greater than the drinking water standard in the 200-East Area is generally found only in unfiltered samples, with the exception of samples from well 299-E24-19, where the maximum concentration detected in a filtered sample collected in 1996 was 140 µg/L. This well is located on the southern boundary of the A-AX single-shell high-level waste tank farms. Chromium concentrations in this well have decreased from a peak in late 1992 (Figure 4.8.38) and were down from the 410 µg/L measured in 1995. Chromium is a component of stainless steel, and its presence in groundwater samples at the Hanford Site is often attributed to corrosion of stainless-steel well components. Nickel, which is another stainless-steel component, also showed elevated concentrations. However, the chromium present in samples from this well does not follow the pattern usually attributed to corrosion of the stainless-steel well casing and well screen. Other stainless-steel wells tend to show elevated chromium values in only the unfiltered samples, and the trends tend

Figure 4.8.36. Distribution of Filtered Chromium in the 100-D and 100-H Areas, 1996



97jpm122 June 24, 1997 4:15 PM

Figure 4.8.37. Distribution of Filtered Chromium in the 100-K Area, 1996



97jpm120 June 24, 1997 5:08 PM

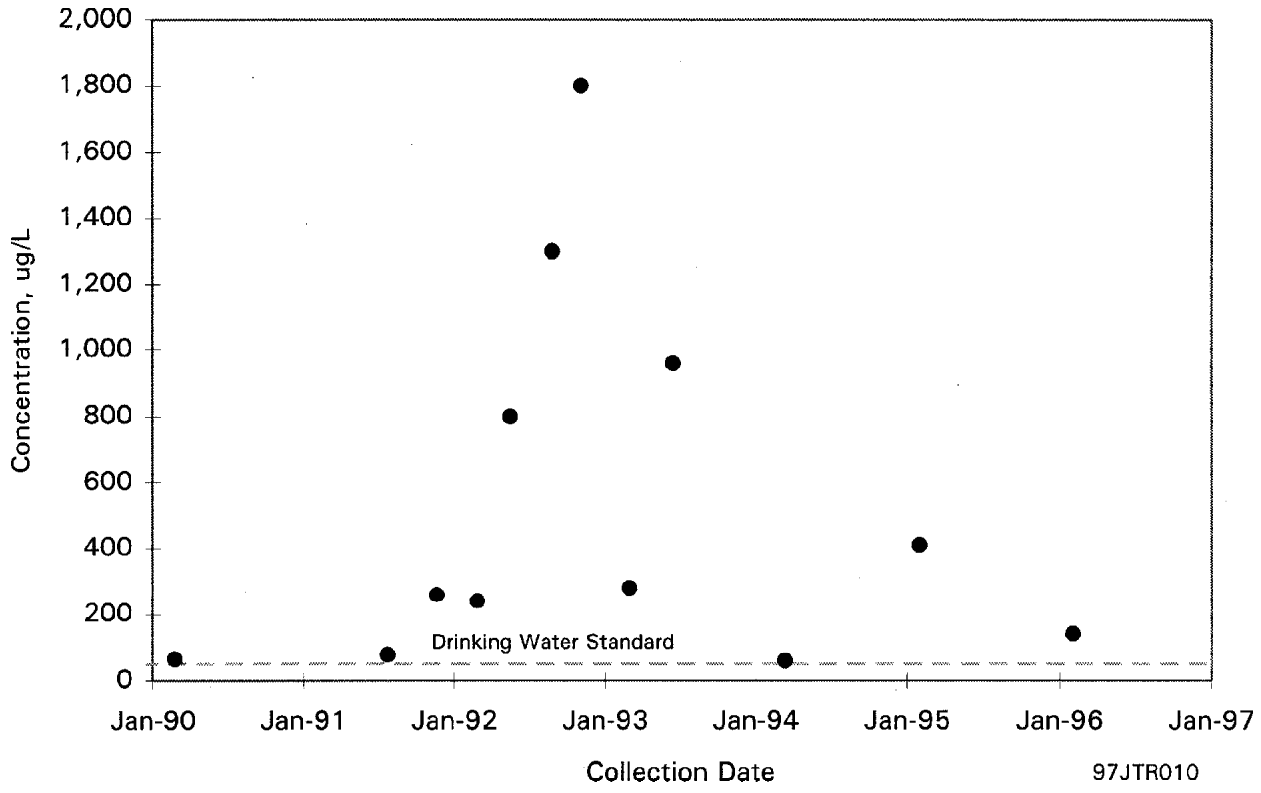


Figure 4.8.38. Filtered Chromium Concentrations in Well 299-E24-19, 1990 Through 1996

to be erratic as the result of variable amounts of particulate matter being present in the sample. Release from the A-AX Tank Farms is a potential source of this chromium contamination.

Chromium contamination has been found at several locations in the 200-West Area and is detected in both filtered and unfiltered samples, though the filtered concentrations tend to be lower. The highest filtered chromium concentration observed in the 200-West Area in 1996 was 590 µg/L at well 299-W11-27, which is located north of the T single-shell tank farm, near facilities that received liquid discharge from T Plant operations.

Chromium in the 300 Area. Chromium is occasionally detected at concentrations greater than the drinking water standard in unfiltered samples from the 300 Area. The concentrations in filtered samples were, in all cases, less than the drinking water standard. This difference suggests that the high chromium concentrations found in these monitoring wells represent particulate matter and are affected by the stainless-steel well construction purging procedures, time between samples, and other factors that do not reflect groundwater quality.

Chromium in Other Areas. Chromium concentrations greater than the drinking water standard have also been detected locally in filtered samples from 600 Area monitoring wells. As discussed above, chromium contamination in the vicinity of the 100-D and 100-H Areas extends into the 600 Area. Filtered samples from several wells, located downgradient of the southern part of the 200-West Area, contained chromium at levels above the drinking water standards. The maximum concentration detected in filtered samples in this area during 1996 was 227 µg/L at well 699-32-62. The extent of chromium contamination in this area is poorly defined, and the source has not been determined.

Carbon Tetrachloride and Chloroform

Carbon tetrachloride contamination was found in the unconfined aquifer beneath much of the 200-West Area. The contamination is believed to be from waste disposal operations associated with the Plutonium Finishing Plant. Carbon tetrachloride was used as the carrier solvent for tributyl phosphate in the final purification of plutonium. Carbon tetrachloride was also used in the same facility as a nonflammable thinning agent while machining

plutonium. Carbon tetrachloride is immiscible in water but exhibits a relatively high solubility (805,000 µg/L at 20°C [68°F]). Carbon tetrachloride has been found to have a relatively high degree of mobility in groundwater. Mobilization above the water table can also occur through vapor transport. The drinking water standard for carbon tetrachloride is 5 µg/L.

The carbon tetrachloride distribution in the 200-West Area groundwater (Figure 4.8.39) has changed slowly since the presence of the contaminant plume was first noted in 1987. Figure 4.8.39 shows the trends in carbon tetrachloride concentrations through time for wells located at the east, west, north, and south parts of the plume. The greatest increases in concentration are found to the north and south of the Plutonium Finishing Plant. The maximum concentration of carbon tetrachloride detected in the 200-West Area in 1996 was 5,170 µg/L in well 299-W15-16. Concentrations in the central part of the carbon tetrachloride plume have declined in recent years. The trend plot (Figure 4.8.40) for well 299-W15-16 illustrates this decline from concentrations over 8,000 µg/L in the late 1980s to values ranging from 3,800 to 5,170 µg/L during 1995 and 1996. The carbon tetrachloride in the most contaminated part of the groundwater plume is being remediated by the pump-and-treat method; vadose zone contamination is removed by vapor extraction.

The extent of carbon tetrachloride contamination is poorly defined in several directions. The greatest uncertainty lies in the extent of contamination to the west and east. In addition, there is considerable uncertainty regarding the extent of contamination in deeper parts of the aquifer.

Changes in groundwater flow since decommissioning U Pond may be influencing the plume configuration and the concentrations at particular locations. Another potential influence is the continued spreading of carbon tetrachloride above the water table, in either the liquid or vapor phase. Free-phase liquid carbon tetrachloride above and possibly below the water table provides a continuing source of contamination. Therefore, lateral expansion of the carbon tetrachloride plume is expected to continue.

In addition to carbon tetrachloride, significant amounts of chloroform were found in 200-West Area groundwater. The drinking water standard for chloroform is 100 µg/L (total trihalomethanes), which is 20 times higher than that for carbon tetrachloride. The highest chloroform level recorded in 1996 was 250 µg/L in well 299-W15-39, located near the Plutonium Finishing Plant. The chloroform plume appears to be associated with, but not exactly coincident with, the carbon tetrachloride plume. Chloroform may result from the degradation of carbon tetrachloride, either in the process or in the subsurface, as the result of biodegradation. The extent of chloroform contamination appears to be decreasing.

Trichloroethylene

Trichloroethylene, which is a commonly used organic solvent, has a drinking water standard of 5 µg/L. In 1996, trichloroethylene was detected at levels greater than the drinking water standard in wells in the 100-F, 100-K, 200-West, and 300 Areas and parts of the 600 Area.

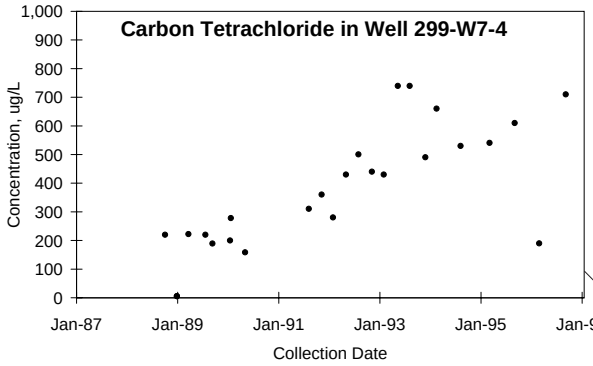
Trichloroethylene in the 100 Areas. Trichloroethylene was detected in 1996 at levels less than the drinking water standard in a few 100-B,C Area wells. It was detected at levels greater than the drinking water standard in some 100-F Area wells. The maximum concentration detected in the 100-F Area in 1996 was 10 µg/L in a sample for well 199-F7-1. In addition, trichloroethylene was found at 19 µg/L in well 699-77-36, west of the 100-F Area, indicating a potential source upgradient.

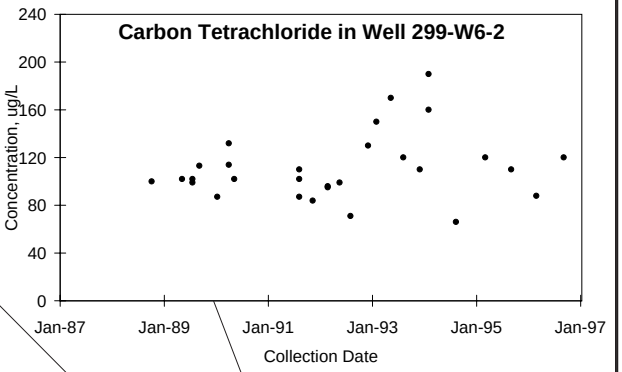
Two wells sampled in 1996 in the 100-K Area contained trichloroethylene at levels above the drinking water standard. The maximum concentration was 27 µg/L in monitoring well 199-K-106A, which is located near the K-West Reactor.

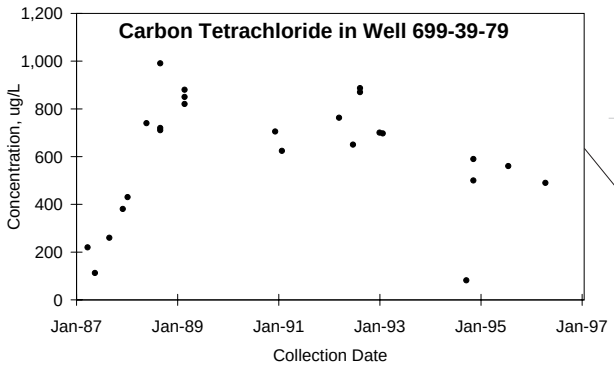
Trichloroethylene in the 200 Areas. Trichloroethylene was detected at levels greater than the drinking water standard in the 200-West Area in several areas in 1996 (Figure 4.8.41). The first area extends from the Plutonium Finishing Plant to the west of T Plant, past the northern boundary of the 200-West Area. Concentrations up to 26 µg/L were detected in 1996 in this plume at well 299-W11-30. The second area of trichloroethylene contamination near U Plant showed a maximum concentration of 15 µg/L at well 299-W19-35 in 1996. Although only a few wells in this area contained trichloroethylene at levels above the drinking water standard, the plume extends into the 600 Area to the east, and the downgradient spread has not been well defined. Trichloroethylene was also measured at 11 µg/L in a sample from well 299-W22-20 near the Reduction-Oxidation Plant.

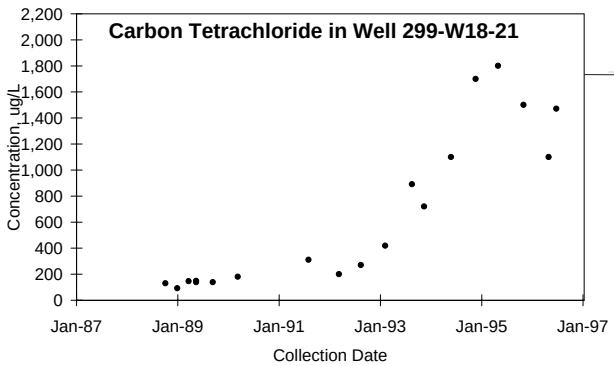
Trichloroethylene in the 300 Area. Trichloroethylene was detected during 1996 at several wells throughout the 300 Area at concentrations below the drinking water standard. The maximum concentration was 3.0 µg/L at well 399-4-12, which is used as a nonpotable water supply for aquatics research (see Figure 4.8.2).

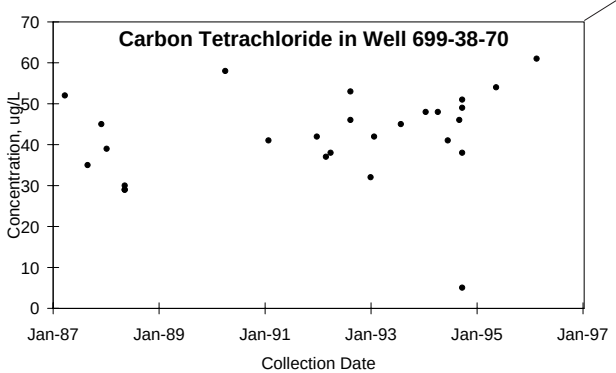
Figure 4.8.39. Distribution of Carbon Tetrachloride in the Unconfined Aquifer in the 200-West Area, 1996, and Concentration Trends for Several Wells Within the 200-West Area

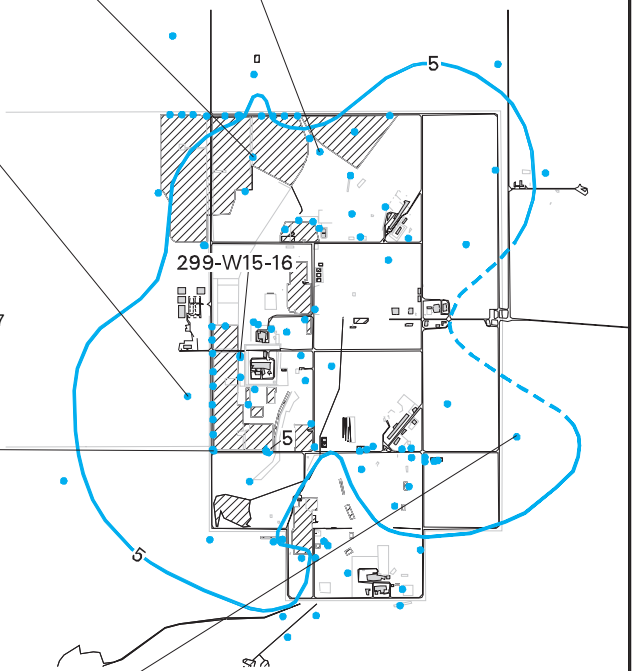

Carbon Tetrachloride in Well 299-W7-4
Concentration, ug/L
1,000
900
800
700
600
500
400
300
200
100
0
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Collection Date

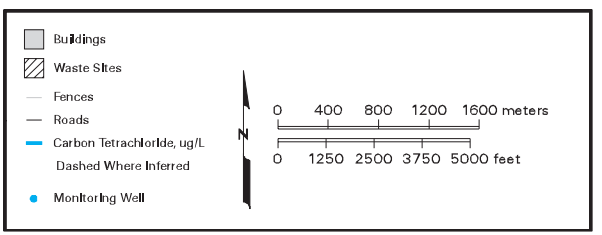

Carbon Tetrachloride in Well 299-W6-2
Concentration, ug/L
240
200
160
120
80
40
0
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Collection Date


Carbon Tetrachloride in Well 699-39-79
Concentration, ug/L
1,200
1,000
800
600
400
200
0
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Collection Date


Carbon Tetrachloride in Well 299-W18-21
Concentration, ug/L
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Collection Date


Carbon Tetrachloride in Well 699-38-70
Concentration, ug/L
70
60
50
40
30
20
10
0
Jan-87
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Collection Date


299-W15-16
5
5
5


Buildings
Waste Sites
Fences
Roads
Carbon Tetrachloride, ug/L
Dashed Where Inferred
Monitoring Well
N
0 400 800 1200 1600 meters
0 1250 2500 3750 5000 feet

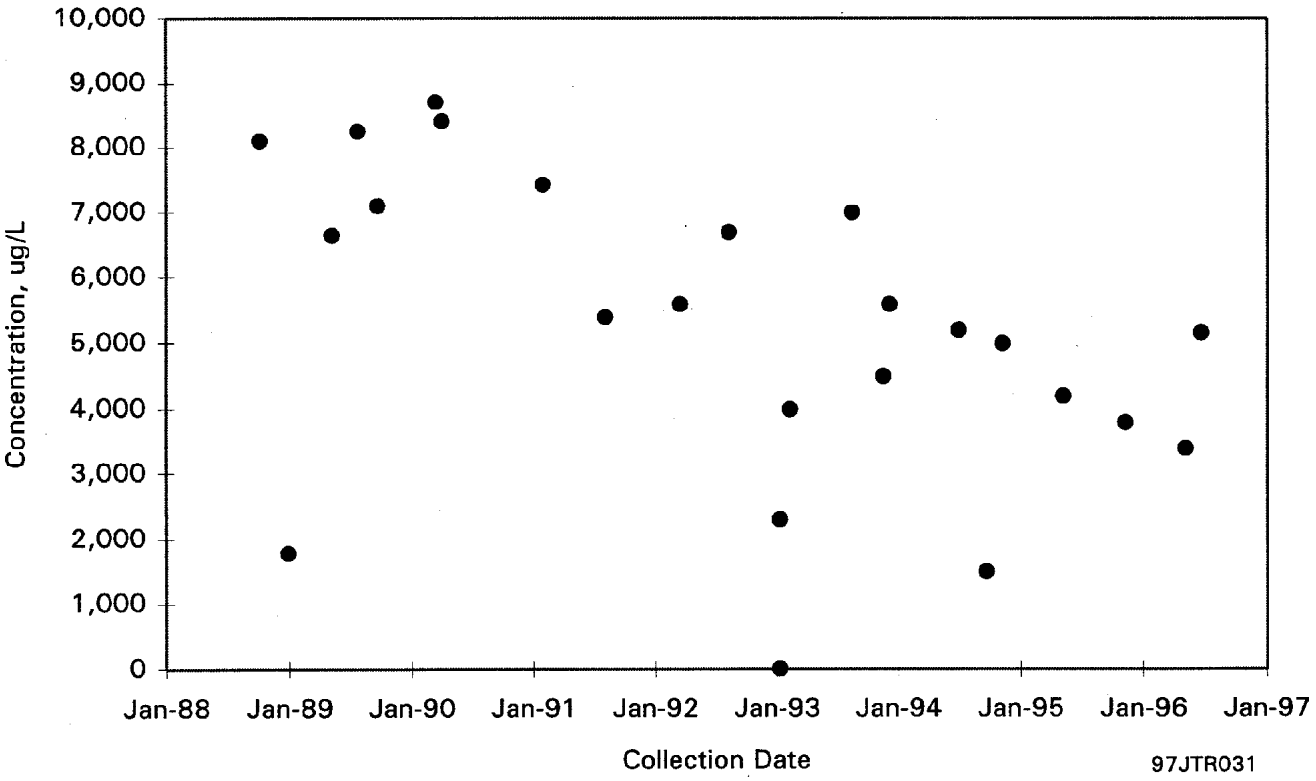


Figure 4.8.40. Carbon Tetrachloride Concentrations in Well 299-W15-16, 1988 Through 1996

Trichloroethylene in the 600 Area. Several wells at the Solid Waste Landfill (part of the Central Landfill) contained trichloroethylene levels that are less than the drinking water standard. The maximum concentration observed in 1996 was 1.5 µg/L at well 699-23-35. Solid Waste Landfill wells showed trichloroethylene concentrations greater than the drinking water standard before 1994. The source of the trichloroethylene in this area is apparently disposal of waste from vehicle maintenance operations in the mid-1980s.

Trichloroethylene was found at levels above the drinking water standard in a number of wells in the vicinity of the Horn Rapids Landfill in the southern part of the site (Richland North Area). This contamination forms a plume leading toward the 300 Area that appears to have an origin off the Hanford Site (Figure 4.8.42). Trend plots shown in Figure 4.8.42 provide an indication of the migration of the trichloroethylene plume toward the northeast in this vicinity. The maximum trichloroethylene contamination detected in this plume in 1996 was 14 µg/L at wells 699-S31-E10A and 699-S31-E10C.

Tetrachloroethylene

Tetrachloroethylene, also referred to as perchloroethylene, was detected at levels below the 5-µg/L drinking water standard in several areas of the site during 1996. These included the 200-West Area, the 300 Area, and parts of the 600 Area. A number of samples from wells in the 1100 and North Richland Areas also contained concentrations of tetrachloroethylene below the drinking water standard. The maximum tetrachloroethylene concentration detected at the Solid Waste Landfill was 3.1 µg/L at well 699-24-34C. Tetrachloroethylene exceeded the drinking water standard in wells near the Solid Waste Landfill before 1994. Tetrachloroethylene is commonly used as a degreasing solvent.

cis-1,2-Dichloroethylene

Concentrations of cis-1,2-dichloroethylene are increasing in well 399-1-16B. This well is completed in the deeper part of the unconfined aquifer in the 300 Area and is the only well onsite where this constituent is found at levels